BIOLOGICAL EVALUATION OF GYPSY MOTH

at

Francis E. Walters Dam

White Haven, PA

Prepared by

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Photos:

On Cover Page *by Karen Felton, USDA FS, Morgantown, WV*

Abstract

During the summer of 2016, Francis E. Walter Dam (FE Walter), which is in the U.S. Army Corps of Engineers (USACE), Philadelphia District in Pennsylvania, experienced gypsy moth defoliation on approximately 15 acres in a timber management area that recently received a silvicultural treatment. In October 2016, USDA Forest Service personnel conducted a gypsy moth egg mass survey at FE Walter to assess the potential for defoliation and the need for treatment in 2017. Current populations are sufficient to cause noticeable defoliation on approximately 200 acres. Treatment is recommended in 2017 in order to prevent tree defoliation, prevent a reduction in oak growth and acorn mast, and prevent possible oak tree mortality.

Purpose and Need

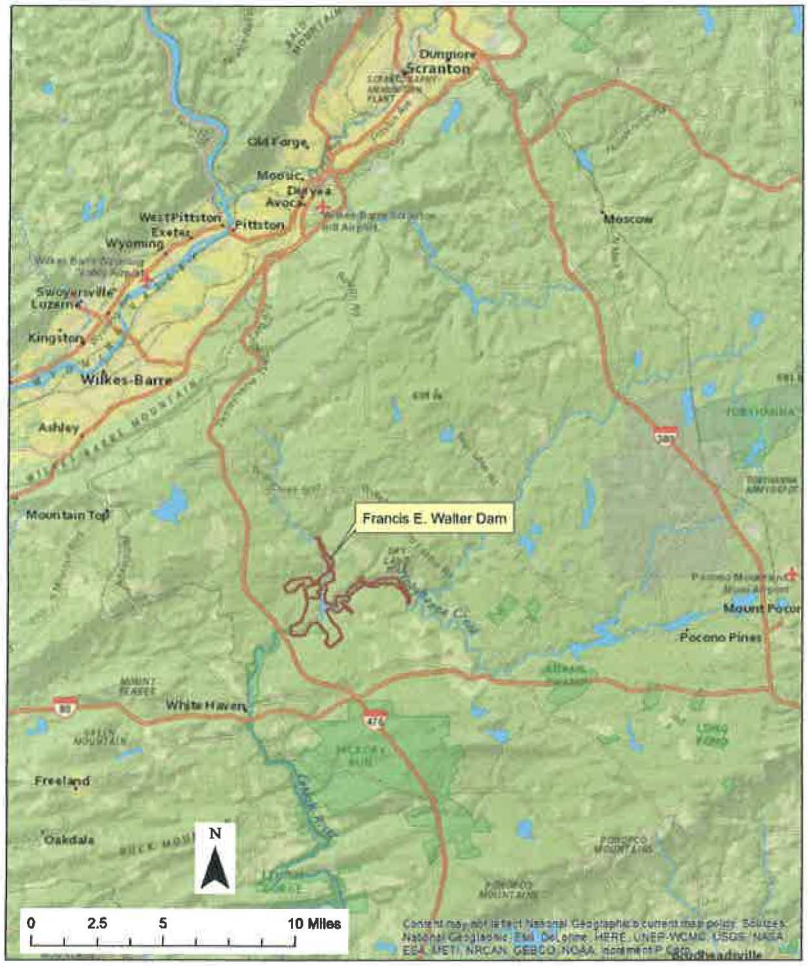
In 2016, the Forest Health Protection unit of the Forest Service, Northeastern Area, State and Private Forestry Field Office (MFO) in Morgantown, WV, received a request from Gregory Wacik, Ecologist, with the ACE Philadelphia District, for a site visit to FE Walter regarding suspected gypsy moth damage. Approximately 15 acres of gypsy moth defoliation was confirmed in a timber management area that recently received a silvicultural treatment. In October 2016, USDA Forest Service personnel conducted a gypsy moth egg mass survey at FE Walter to assess the potential for defoliation and the need for treatment in 2017.

Project Location/Description

The Francis E. Walter Dam was constructed in 1961 for flood risk management in the Lehigh River Valley. Francis E. Walter Dam is a 1,800-acre project, having a small 80 acre reservoir but no Corps-operated recreation facilities. The Philadelphia District USACE actively manages the forested areas of this project. The proposed treatment area is comprised mostly of oaks, and is valued for recreation and wildlife habitat.

FE Walter is located in Luzerne County in eastern Pennsylvania near White Haven, PA (Figure 1).

Figure 1. *General location of Francis E Walter Dam, White Haven, PA.*



Species Evaluation

The gypsy moth, *Lymantria dispar* (Linneaus) is a non-native defoliator of forest, shade and ornamental trees throughout the Northeastern United States. Since its intentional importation and accidental release in eastern Massachusetts in 1869, the gypsy moth has steadily expanded its range. Despite many attempts to halt its spread westward from the northeastern United States; Pennsylvania experienced its first gypsy moth defoliation in 1968. Since that time, the gypsy moth has defoliated nearly 28 million acres in the state.

The gypsy moth produces one generation per year. Larvae begin hatching from egg masses in late April and early May when tree buds begin to open. At this time, larvae go through an obligatory dispersal period where they leave the vicinity of the egg, moving upward and spinning a thread of silk as they go (Leonard 1981). Eventually the wind catches the larvae and disperses them. Airborne larvae are carried

and deposited some distance downwind from the source with the following results: 1) larvae will land on or crawl onto acceptable host plants and begin feeding; 2) larvae will land on either acceptable or unacceptable host plants and re-disperse; 3) larvae will be deposited into areas unacceptable for survival and re-dispersal where they will die (Mason and McManus 1981). The larvae feed for two to three months completing their development by late June and early July and seek sheltered areas in which to pupate. The pupal period last anywhere from 10 days to two weeks. After emerging from the pupal case the females, which cannot fly, crawl a short distance and emit a pheromone scent to attract males. After mating, the female lays a single egg mass that contains from 75 to 1,000 eggs, which she covers with hairs from her abdomen giving it a fuzzy brown texture and color. The egg masses over winter and hatch the following spring.

The number of host trees and shrubs fed on by the gypsy moth exceeds 300 species, with species of oaks (*Quercus* spp.) ranked among the most favored (Leonard 1981). Gypsy moth is an outbreak species whose populations can remain at low levels for several years, then undergo large population increases in a matter of one or two years. After populations have increased to an outbreak density they can remain high for one to five years, outbreaks decline suddenly to low densities where it is difficult to find any life stage (Liebhold et al. 2000). The main effects of gypsy moth feeding on individual trees involves the depletion of root carbohydrate food resources leading to a reduction in growth, reproduction, and increased vulnerability to secondary agents of mortality. Heavy defoliation forces re-foliation which occurs when about 60 percent of the foliage is lost (Liebhold et al. 1994). This re-foliation uses carbohydrate reserves in trees and can increase their vulnerability to drought and to other insects and diseases. This defoliation and subsequent tree mortality can alter wildlife habitats, change water quality and temperature, increase forest floor temperatures and light levels and reduces aesthetic, recreational, and property values of forests and urban environments.

Project Objectives

The objectives of this biological evaluation are to: 1) accurately assess current gypsy moth population densities; 2) determine the likelihood of unacceptable impacts on forest resources occurring in the next growing season; and 3) develop treatment alternatives and recommendations to suppress gypsy moth outbreaks likely to cause unacceptable impacts.

Project Methods

Gypsy moth survey plots were randomly selected based upon available host trees (oak species) in the timber management areas in and adjacent to the area that experienced gypsy moth defoliation during the summer of 2016 at FE Walters.

At each sample point, a 1/40th acre fixed radius plot was established. An inspection of all egg masses within reach was used to estimate the portion of new (2016) to old egg masses at each plot (percent new egg masses). This percentage was applied to the tally of all egg masses observed above the reachable surface. The plots consisted of a tally of all new egg masses observed on overstory trees, understory

vegetation, ground litter and duff. The total number of new egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre (Leibhold et al. 1994).

Defoliation predictions for 2017 are based on the egg mass density, threshold, egg mass length, population trends, and species composition (Liebhold et al. 1994, Leibhold et al. 1993; Table 1). Intervention thresholds were established on resource management objectives and nuisance abatement, and the prevention of defoliation (Table 1).

Table 1. *2016 Gypsy moth egg mass density thresholds for resource management objectives at FE Walters Dan, White Haven, PA.*

Threshold (egg masses/acres)	Predicted Defoliation	Objectives
250	< 30[1] %	Nuisance Abatement
251-500	30 - 40 % (Light)	Prevent Noticeable Defoliation
501-1000	41 - 60 % (Moderate)	Prevent Growth Loss
>1000	> 60 % (Heavy)	Prevent Mortality

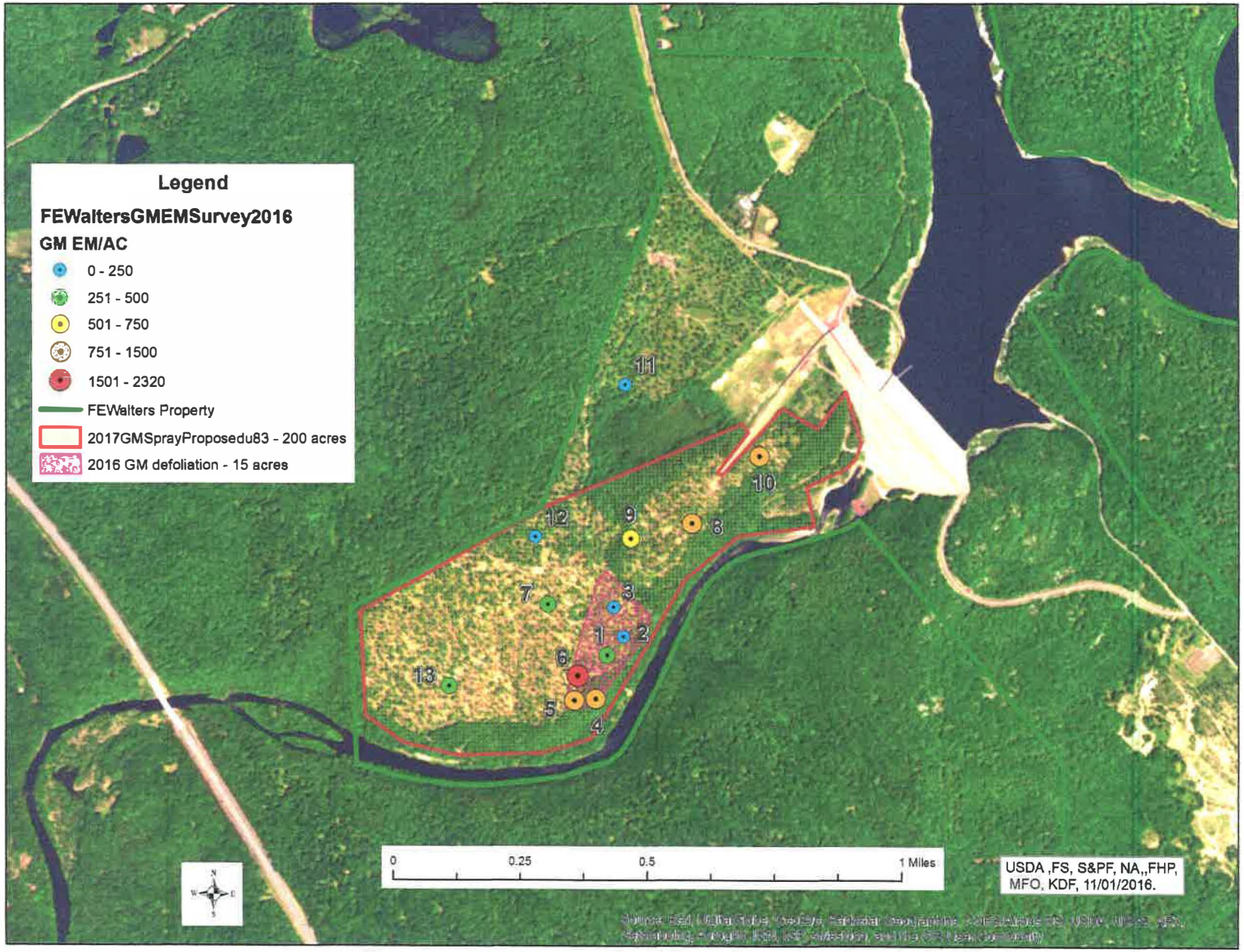
[1] None or background level of defoliation.

Egg mass length was measured at most of the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity. Small egg masses (<20 mm in length) are indicative of a declining population, while large egg masses (>30 mm in length) of an increasing population (Liebhold et al. 1994). The average egg mass length (measured in millimeters) and egg mass density (egg masses per acre) are used to estimate defoliation potential (Liebhold et al., 1993).

Results

A total of 13 plots was established (Figure 2); and egg mass densities per acre throughout the survey area at FE Walter ranged from 0-2040 and averaged 677 egg masses per acre (Table 2). Survey results indicate the highest densities occurring in the southern part of the survey area on approximately 200 acres and the remaining area on the north end had very low densities (below 250 em/ac). Within this southern area the average egg masses was 734 em/acre and range was the same as the whole area; and are high enough to cause light to heavy defoliation within portions of the area. Overall average egg mass lengths ranged from 32-35 mm and averaged 34 mm.

Figure 2. *2016 gypsy moth egg mass survey plot locations and the 2017 proposed treatment block (200 acres- 1 application of Btk) at Francis E Walter Dam, Pennsylvania.*



Defoliation prediction is further supported by using egg density as a means of estimating gypsy moth population densities. Moore and Jones (1987) found that estimating the mean fecundity would increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and predicting defoliation. The average egg mass density of 734 egg masses per acre x 34 mm (average egg mass length) translates to a projected defoliation level of about 37 percent (moderate defoliation) within the proposed spray block. This represents an overall average and since egg mass densities and host type are not evenly distributed, actual defoliation will vary somewhat from tree to tree throughout the area.

The summarized results of the survey are presented in Table 2.

Table 2. *2016 Gypsy moth egg mass survey results at the Francis E Walter Dam, PA.*

Plot Number	Average Egg Masses per Acre	EM Density Predicted Defoliation (%)	Liebhold et al. GM EM Size and Density Predicted Defoliation (%)
1	440	30 - 40 %	32 %
2	0	< 30 %	< 30 %
3	0	< 30 %	< 30 %
4	1200	> 60 %	44 %
5	1080	> 60 %	44 %
6	2320	> 60 %	68 %
7	480	30 - 40 %	32 %
8	840	41 – 60 %	41 %
9	520	41 – 60 %	34 %
10	1400	> 60 %	46 %
11	0	< 30 %	< 30 %
12	80	30 - 40 %	< 30 %
13	440	30 - 40 %	32 %
Total average = 667 gm em/acre, range 0-2040 **Proposed Spray Block** **Average = 734 gm em/acre, range 0=2040**			

Discussion

The survey results indicate that noticeable defoliation (light to moderate) is likely to occur on approximately 200 acres in at FE Walter. Since egg mass densities and host type are not evenly distributed, actual defoliation will vary somewhat from tree to tree throughout the area.
At FE Walter the average egg mass length is 34 mm indicating a stable to increasing population, but both the fungus and virus were observed in these stands in 2016 and it is possible that either could cause

a general collapse next year if wet weather conditions occur in the spring of 2017. However, a population collapse is not likely to occur prior to a defoliation event in 2017.

Since defoliation reduces the trees ability for future photosynthesis and re-foliation events causes the tree to expend carbohydrate reserves, these factors that must be considered when deciding whether intervention is necessary or warranted. Other factors that need to be considered are the condition of the trees at the time of defoliation (i.e. stand stocking, age and amount of susceptible species present). Studies have shown (Gottschalk 1989), that reduced growth, mast abortion, branch dieback or in some cases tree mortality, has been observed following a single year of heavy defoliation. Should a subsequent period of drought or other stressors occur during a defoliation event or even after, the potential impact on individual trees may be compounded

Management Options

For 2017, two management options have been evaluated for managing gypsy moth populations at FE Walter. The intervention option is offered based upon the following treatment objective: protect host tree foliage to prevent branch dieback, mast production failure, and tree mortality. Each option is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the fungal pathogen, *E. maimaiga.* In areas with defoliating levels of gypsy moth populations (greater than 500 egg masses per acre) viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels. Although it is not possible to accurately assess such events with information at hand, it is unlikely that a collapse will occur prior to defoliation.

Should this option be selected, it is likely that noticeable defoliation will occur at FE Walter in 2017. There is also the potential for population densities to increase in infested stands and expand to currently un-infested areas in 2017.

Intervention Option
Microbial Insecticide Option

***Btk*:** The second option is to use microbial insecticides to manage gypsy moth populations. Only one biological insecticide is currently registered and commercially available for gypsy moth control. It is the microbial insecticide, *Bacillus thuringiensis* variety *kurstaki* (*Btk*). *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis, which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* has been shown to impact other non-target caterpillars that are exposed to the treatment when actively feeding. *Btk* is persistent on foliage for about 7-10 days.

Btk is not specific and may reduce populations of short term non-target lepidoptera larvae that may be feeding at the same time as gypsy moth caterpillars. Several factors must be taken into account when using *Btk* such as: 1) the potential for short term non-target extirpation in the proposed spray area; 2) the life stage present and any deferential susceptibility to *Btk* that may exist between species of non-target lepidoptera; 3) the size and uniqueness of the area beginning proposed for treatment. Since much of this site-specific data regarding non-target lepidoptera may not be known for many areas, the potential benefits must be weighed against any potential impacts to non-targets.

Btk formulations are available as a flowable concentrate. The normal application rates range from 24-78 Cabbage Looper Units (CLU's) per acre in a single application for a total volume of ½ to ¾ gallon per acre. Double applications may be used in areas of healthy building populations where the egg mass densities may exceed 3,000 egg masses per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application. Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product (CLU's).

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it can be difficult to project treatment efficacy with less than optimal conditions following treatment. Most often foliage protection is achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 2×10^{11} occlusion bodies (OB's) per acre applied in two applications, or a single application at 4×10^{11} OB's. Supplies are limited, priority is given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments.

Management Alternatives

With the previously described options in mind, the following alternatives are offered.

Alternative 1 - No action

Alternative 2 - One aerial application of *Btk* at the rate of 24-78 CLUs in a total mix of ½ to ¾ gallon per acre. Population densities do not warrant a double application.

Recommendations

As previously stated, gypsy moth populations are sufficient to cause noticeable defoliation (light to moderate) at FE Walter in 2017. The Philadelphia District USACE actively manages the forested areas of this project. The proposed treatment area is comprised mostly of oaks, and is valued for recreation and wildlife habitat. Taking this into account, our recommendation is Alternative 2; one aerial application of *Btk* at the rate of 24-78 CLUs in a total mix of ½ to ¾ gallon per acre on 200 acres, in order to help protect tree foliage, prevent possible mast production failure and prevent possible tree mortality. Population densities do not warrant a double application.

References

Gottschalk, K.W. 1989. Gypsy moth impacts on mast production, *In:* McGee, Charles E. Ed. Proceedings of the Workshop, southern Appalachian Mast Management; 1989 August 14-16; Knoxville TN; University of Tennessee; 42-50.

Leonard, D.E. 1981. Bioecology of the Gypsy Moth. In: The Gyspy Moth : Research Toward Integrated Pest Management. USDA Forest Service, Technical Bulletin 1584 pp. 9-29.

Liebhold, A.M., J. Elkinton, D. Williams, and R.M. Muzika. 2000. What causes outbreaks of the gypsy moth in North America? Popul. Ecol. 42:257-266.

Liebhold, A.M., K. Thorpe, J. Ghent, and D.B. Lyons. 1994. Gypsy Moth Egg Mass Sampling for a Decision-Making: A Users' Guide. USDA Forest Service, Technical Bulletin NA-TP-04-94 pp. 21.

Liebhold, A.M., Simons, E.E., Sior, A., and Unger, J.D. 1993. Forecasting defoliation caused by the gypsy moth from field measurements. Environ. Entomol. 22(1): 26-32.

Mason, C.J. and M.L. McManus. 1981. Larval Dispersal of the Gyspy Moth. *in*: The Gypsy Moth : Research Toward Integrated Pest Management. USDA Forest Service, Technical Bulletin 1584 pp. 161-202.

Moore, K.E.B. and Jones, C.G. 1987. Field estimation of fecundity of gypsy moth (Lepidoptera Lymnatriidae). Environ. Entomol. 16: 165-167.

Forest Service

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File Code: 3420
Date: November 29, 2016

Mr. Gregory A Wacik, Ecologist
US Army Corps of Engineers
Philadelphia Disrtict
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Wacik:

Enclosed is the 2016 gypsy moth biological evaluation for the Francis E. Walter Dam (FE Walter). During the summer of 2016, approximately 15 acres of gypsy moth defoliation was confirmed at FE Walter, in a timber management area that recently received a silvicultural treatment. In October 2016, USDA Forest Service personnel conducted a gypsy moth egg mass survey at FE Walter to assess the potential for defoliation and the need for treatment in 2017. Current populations are sufficient to cause noticeable defoliation on approximately 200 acres. Treatment is recommended in 2017 in order to prevent tree defoliation, prevent a reduction in oak growth and acorn mast, and prevent possible oak tree mortality. As you are aware, this gypsy moth treatment block has been refined to 192 acres by the Pennsylvania DCNR Bureau of Forestry, Division of Forest Health staff to make the spray block more flyable for inclusion in their 2017 Gypsy Moth Suppression Program.

We will continue to work with you and David Williams from FE Walter, and have greatly appreciated the assistance.

If you have any questions concerning this biological evaluation, please contact Karen Felton (304-285-1556) or Rick Turcotte (304-285-1544).

Sincerely,

Robert Lueckel

ROBERT LUECKEL
Field Representative

Enclosure

Cc: David Williams, FE Walter Dam
Scott Stitzer, PA DCNR
Tim Marasco, PA DCNR